I claim:

1. A water softening apparatus adapted to be placed in fluid communication with a water drain, a processing device, a water source that provides water containing undesired ions, and a water tap that dispenses water for consumption, said water softening apparatus operative to remove the undesired ions from water processed thereby, comprising:

(a) a resin vessel sized and adapted to receive a selected volume of a fluid, said resin vessel containing an ion-exchange resin that is capable of chemically shifting between an active state operative to exchange selected preferred ions therein for the undesired ions contained in the water when in contact therewith and an exhausted state operative to exchange the undesired ions therein for the selected preferred ions contained in a regenerant solution when in contact therewith;

(b) a regenerant reservoir adapted to receive the regenerant solution containing the selected preferred ions; and

(c) a manifold in fluid communication with said resin vessel and said regenerant reservoir, said manifold having a first inlet in fluid communication with the water source, a first outlet in fluid communication with the water tap, a second outlet in fluid communication with the water drain, and a third outlet in fluid communication with the processing device, said manifold including a plurality of fluid pathways communicating between said inlet, said outlets, said resin vessel and said regenerant reservoir, and a plurality of valves associated with said fluid pathways that are configurable into a plurality of valve states whereby in a first valve state fluid can flow through said first inlet, through said resin vessel and through said first outlet, whereby in a second valve state fluid can flow from said regenerant reservoir through said resin vessel and through said second outlet, whereby in a third valve state fluid can flow from said regenerant reservoir through said resin vessel and through said third outlet, and whereby in a fourth valve state fluid

can flow through said first inlet, through said resin vessel and into said regenerant reservoir.

2. A water softening apparatus according to claim 1 wherein said valves are further configurable into a fifth valve state whereby fluid can flow through said first inlet, through said resin vessel and through said second outlet.

3. A water softening apparatus according to claim 1 including a pump in fluid communication with said regenerant reservoir and said manifold and operative to pump regenerant solution from said regenerant reservoir to said manifold.

4. A water softening apparatus according to claim 3 including a flow controller in fluid communication with said regenerant reservoir and said manifold and operative to control a flow rate of the regenerant solution from said regenerant reservoir.

5. A water softening apparatus according to claim 1 wherein said resin vessel includes a first combination inlet/outlet in fluid communication with said first inlet of said manifold and a second combination inlet/outlet in fluid communication with said first outlet of said manifold.

6. A water softening apparatus according to claim 5 wherein said resin vessel includes a resin vessel outlet in fluid communication with said second outlet of said manifold.

7. A water softening apparatus according to claim 5 wherein said first combination inlet/outlet is further in fluid communication with said third outlet of said manifold.

8. A water softening apparatus according to claim 5 wherein said second combination inlet/outlet is further in fluid communication with said regenerant reservoir.

9. A water softening apparatus according to claim 5 wherein said manifold includes a third combination inlet/outlet in fluid communication with said regenerant reservoir.

10. A water softening apparatus according to claim 1 wherein said manifold is a modified Autotrol Series 169 multi-port valve.

11. A water softening apparatus according to claim 1 wherein said ion-exchange resin is a shallow shell/shortened diffusion path resin.

12. A water softening apparatus according to claim 1 wherein said ion-exchange resin is selected from the group consisting of Purolite SST and Purolite C100FM resins.

13. A water softening system, comprising:

(a) a water source that provides water containing undesired ions;

(b) a water tap that dispenses water for consumption;

(c) a water drain;

(d) a processing device;

(e) a regenerant reservoir that is sized and adapted to receive a selected volume of a regenerant solution containing selected preferred ions;

(f) a resin vessel sized and adapted to receive a selected volume of a fluid;

(g) an ion-exchange resin disposed in said resin vessel, said ion-exchange resin capable of chemically shifting between an active state operative to exchange the selected preferred ions therein for the undesired ions contained in the water when in contact therewith and an exhausted state operative to exchange the undesired ions therein for the selected preferred ions contained in the regenerant solution when in contact therewith; and

(h) a manifold in fluid communication with said resin vessel and said regenerant reservoir, said manifold having a first inlet in fluid communication with said water source, a first outlet in fluid communication with said water tap, a second outlet in fluid communication with said water drain, and a third outlet in fluid communication with said processing device, said manifold including a plurality of fluid pathways communicating between said inlet, said outlets, said resin vessel and said regenerant reservoir, and a plurality of valves associated with said fluid pathways that are configurable

into a plurality of valve states whereby in a first valve state water from said water source flows through said first inlet, through said resin vessel and through said first outlet to said water tap when said ion-exchange resin is in the active state thereby to remove the undesired ions from the water, whereby in a second valve state regenerant solution flows from said regenerant reservoir into said resin vessel and water flows from said resin vessel through said second outlet to said water drain, whereby in a third valve state regenerant solution flows from said regenerant reservoir into said resin vessel when said ion-exchange resin is shifted toward the exhausted state thereby to shift the ion-exchange resin toward the active state and form a waste solution that flows through said third outlet to said processing device, and whereby in a fourth valve state water from said water source flows through said first inlet, through said resin vessel and into said regenerant reservoir thereby to replenish the volume of fluid therein.

14. A water softening system according to claim 13 wherein the undesired ions are calcium and magnesium ions.

15. A water softening system according to claim 13 wherein said processing device is an evaporation device.

16. A water softening system according to claim 13 wherein the regenerant solution is a brine solution.

17. A water softening system according to claim 13 wherein said valves are further configurable into a fifth valve state whereby water from said water source flows through said first inlet, through said resin vessel and through said second outlet to said water drain.

18. A method for softening water that contains undesired ions, comprising:

(a) providing an ion-exchange resin in a resin vessel sized and adapted to receive a fluid, wherein said ion-exchange resin is capable of chemically shifting between an active state operative to exchange selected preferred ions therein for the undesired ions contained in the water when in

contact therewith and an exhausted state operative to exchange the undesired ions therein for the selected preferred ions contained in a regenerant solution when in contact therewith;

(b) contacting said ion-exchange resin with the water that contains the undesired ions when said ion-exchange resin is shifted toward the active state, thereby to remove the undesired ions from the water and shift said ion-exchange resin toward the exhausted state;

(c) contacting said ion-exchange resin with the regenerant solution containing the selected preferred ions when said ion-exchange resin is shifted toward the exhausted state, thereby to remove the preferred ions from the regenerant solution so as to shift said ion-exchange resin toward the active state and form a waste solution containing the undesired ions, and thereby to displace a selected volume of water from said resin vessel and pass the selected volume of water to a water drain; and

(d) collecting said waste solution thereby to permit selective disposal of the undesired ions via a processing device that is separate from a drainage line.

19. A method according to claim 18 wherein the step of collecting said waste solution is accomplished by displacing said waste solution in said resin vessel with the regenerant solution and passing said waste solution to said processing device.

20. A method according to claim 19 including the step of displacing said regenerant solution in said resin vessel with water and passing to a regenerant reservoir a volume equal to the amount of regenerant solution used in the regeneration cycle.

21. A method according to claim 18 wherein the step of contacting said ion-exchange resin with the regenerant solution includes contacting said ion-exchange resin with between 0.25 and 2.0 bed volumes of the regenerant solution.

22. A method according to claim 18 wherein the step of contacting said ion-exchange resin with the regenerant solution includes transporting the regenerant solution from a regenerant reservoir into said resin vessel.

23. A method according to claim 22 wherein the regenerant solution is transported by pumping the regenerant solution from the regenerant reservoir into said resin vessel.

24. A method according to claim 18 wherein the step of collecting said waste solution includes transporting said waste solution to an evaporation device.

25. A method according to claim 18 including the step of rinsing said ion-exchange resin with water thereby to form a rinse solution and thereafter transporting the rinse solution to a regenerant reservoir.

26. A method according to claim 25 including the step of adding rock salt to said regenerant reservoir, thereby to form a brine solution from said rinse solution.

27. A method for softening hard water using a water softening apparatus that includes an ion-exchange resin disposed in a resin vessel that is sized and adapted to receive a selected volume of a fluid, wherein said ion-exchange resin is one that is operative to soften hard water, the method comprising:

(a) displacing any water in said resin vessel with a regenerant solution, wherein said regenerant solution is operative to regenerate said ion-exchange resin when said ion-exchange resin is exhausted and thereby form in said resin vessel a waste solution having salt contaminants therein;

(b) transporting said displaced water to a water drain adapted to receive water for disposal;

(c) displacing any waste solution in said resin vessel with said regenerant solution thereby to fill said resin vessel with said regenerant solution;

(d) transporting said displaced waste solution to a processing device operative to process a solution having salt contaminants therein;

(e) displacing any regenerant solution in said resin vessel with water thereby to rinse said ion-exchange resin and form a rinse solution in said resin vessel;

(f) transporting said displaced regenerant solution to a regenerant reservoir adapted to receive said regenerant solution;

(g) displacing any rinse solution in said resin vessel with water;

(h) transporting said displaced rinse solution to at least one of said regenerant reservoir and said water drain;

(i) flowing hard water through said resin vessel thereby to contact said hard water with said ion-exchange resin to form softened water; and

(j) transporting said softened water to a water tap operative to dispense said softened water for consumption.

28. A water softening apparatus adapted to be placed in fluid communication with a water drain, a processing device, a water source that provides water containing undesired ions, and a water tap that dispenses water for consumption, said water softening apparatus operative to remove the undesired ions from water processed thereby, comprising:

(a) a resin vessel sized and adapted to receive a selected volume of a fluid, said resin vessel having an upper portion and a lower portion, said lower portion containing a selected amount of an ion-exchange resin ;

(b) a regenerant reservoir adapted to receive a selected volume of a fluid; and

(c) a manifold in fluid communication with said resin vessel and said regenerant reservoir, said manifold having:

(1) a first inlet adapted to be placed in fluid communication with the water source;

(2) a first outlet adapted to be placed in fluid communication with the water tap;

(3) a second outlet adapted to be placed in fluid communication with the water drain;

(4) a third outlet adapted to be placed in fluid communication with the processing device;

(5) a first conduit fluidly communicating between said first inlet, said third outlet, and said upper portion of said resin vessel;

(6) a second conduit separate from said first conduit and fluidly communicating between said second outlet and said upper portion of said resin vessel;

(7) a third conduit separate from said first and second conduits and fluidly communicating between said first outlet, said second outlet, said regenerant reservoir and said lower portion of said resin vessel;

(8) a plurality of valves disposed in said conduits, wherein said valves are configurable into a plurality of valve states

(A) whereby in a first valve state fluid can flow from said first inlet, through said first conduit into said upper portion of said resin vessel, through said ion-exchange resin in said lower portion of said resin vessel in a downflow direction, into said third conduit and out said first outlet;

(B) whereby in a second valve state fluid can flow from said regenerant reservoir, through said third conduit into said lower portion of said resin vessel, through said ion-exchange resin in said lower portion of said resin vessel in an upflow direction, through said second conduit and out said second outlet;

(C) whereby in a third valve state fluid can flow from said regenerant reservoir, through said third conduit into said lower portion of said resin vessel, through said ion-exchange

resin in said lower portion of said resin vessel in an upflow direction, through said first conduit and out said third outlet; and

(D) whereby in a fourth valve state fluid can flow from said first inlet, through said first conduit into said upper portion of said resin vessel, through said ion-exchange resin in said lower portion of said resin vessel in a downflow direction, through said third conduit and into said regenerant reservoir.

29. A water softening apparatus adapted to be placed in fluid communication with a water drain, a processing device, a water source that provides water containing undesired ions, and a water tap that dispenses water for consumption, said water softening apparatus operative to remove the undesired ions from water processed thereby, comprising:

(a) a resin vessel sized and adapted to receive a selected volume of a fluid, said resin vessel having an upper portion and a lower portion, said lower portion containing a selected amount of an ion-exchange resin, wherein said resin vessel includes a mouth in said upper portion of said resin vessel, a first tube extending through said mouth and opening into said lower portion of said resin vessel, and a second tube extending through said mouth and opening into said upper portion of said resin vessel;

(b) a regenerant reservoir adapted to receive a selected volume of a fluid; and

(c) a manifold in fluid communication with said resin vessel and said regenerant reservoir, said manifold having:

(1) a first inlet adapted to be placed in fluid communication with the water source;

(2) a first outlet adapted to be placed in fluid communication with the water tap;

(3) a second outlet adapted to be placed in fluid communication with the water drain;

(4) a third outlet adapted to be placed in fluid communication with the processing device;

(5) a first conduit fluidly communicating between said first inlet, said third outlet, and said mouth of said resin vessel;

(6) a second conduit separate from said first conduit and fluidly communicating between said second outlet and said second tube of said resin vessel;

(7) a third conduit separate from said first and second conduits and fluidly communicating between said first outlet, said second outlet, said regenerant reservoir and said first tube of said resin vessel;

(8) a plurality of valves disposed in said conduits, wherein said valves are configurable into a plurality of valve states

(A) whereby in a first valve state fluid can flow from said first inlet, through said first conduit and through said mouth into said upper portion of said resin vessel, through said ion-exchange resin in said lower portion of said resin vessel in a downflow direction, through said first tube and into said third conduit and out said first outlet;

(B) whereby in a second valve state fluid can flow from said regenerant reservoir, through said third conduit and through said first tube into said lower portion of said resin vessel, through said ion-exchange resin in said lower portion of said resin vessel in an upflow direction, through said second tube and into said second conduit and out said second outlet;

(C) whereby in a third valve state fluid can flow from said regenerant reservoir, through said third conduit and through said first tube into said lower portion of said resin vessel, through said ion-exchange resin in said lower portion of

said resin vessel in an upflow direction, through said mouth and into said first conduit and out said third outlet; and

(D) whereby in a fourth valve state fluid can flow from said first inlet, through said first conduit and through said mouth into said upper portion of said resin vessel, through said ion-exchange resin in said lower portion of said resin vessel in a downflow direction, through said first tube and through said third conduit and into said regenerant reservoir.

30. A water softening apparatus according to claim 29 wherein said first and second tubes and said mouth are concentric.